Bellcomm

955 L'Enfant Plaza North, S.W.
Washington, D. C. 20024

B72 02002

date: February 4, 1972

to: Distribution

from: R. C. Purkey

subject: Visibility of the Skylab from the U.S. - Case 610

ABSTRACT

The relative frequency that the Skylab will be visible over three U.S. cities was determined. These opportunities were computed from the projected Skylab orbit and therefore do not show the exact times of possible observations since dispersions and changes in launch parameters could change the projected Skylab orbit which would slightly shift some of the viewing dates. The results show that Seattle will have 94 days with viewing opportunities while Los Angeles will have only 35 during the 240-day mission.

(NASA-CR-126218) VISIBILITY OF THE SKYLAB FROM THE US (Bellcomm, Inc.) 7 p

N79-71936

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MEMORANDUM FOR FILE

Introduction

A sunlit manned space station streaking through the darkening sky should be an interesting sight to most people. The orbit inclination of 50° will present an unusual opportunity for all the U.S. population (except Alaskans) and most of the world to view it firsthand. These visual sightings of Skylab may be used to increase the public awareness of space activity. Therefore, this study was undertaken to determine the relative frequency the Skylab could be seen from several major U.S. cities. If these viewing opportunities were deemed numerous enough, times and locations of viewing opportunities could be publicized.

Determination of Viewing Opportunities

In order to determine the viewing opportunities, the maximum range which Skylab could pass a ground site and be visible with the brilliance of a first magnitude star had to be computed. This brightness level was chosen to insure easy identification by an untrained observer. The brightness of Skylab as seen by approaching astronauts during rendezvous was determined in References 1 and 2. This study provided data on the brightness of the Skylab viewed from various ranges and at various attitudes with respect to the astronauts. The results of this study showed that the brightness of the Skylab was principally a function of the range to the observer. Since this data was computed with the assumption that the observer and the Skylab were both above the atmosphere, the data had to be corrected to account for a ground-based observer. This correction was made by using the transmissivity of the atmosphere which accounts for the loss of flux in every light ray that passes through the atmosphere. The transmissivity of clear air was given in Reference 3 as:

$$T = e^{-.223 \sec \xi}$$

where

T = transmissivity
ξ = angle from the local vertical to the line-of-sight to the vehicle.

This factor was used to reduce the brilliance of the Skylab at every value of a range. The maximum range corresponding to brightness of a first magnitude star was found from this data to be 312 nm at an elevation angle of 49°.

The other factor that determined visibility was the lighting that existed in orbit and at the ground site. It was determined that the Skylab was never bright enough to be seen from a sunlit ground site. Therefore, conditions for visibility were that the ground site should be dark and the Skylab be sunlit. The sun elevation angles that correspond to these lighting conditions were computed taking into account the atmospheric refraction of sunlight. It was found that the ground site would be dark enough if the sun elevation angle was less than -1/2 degree. It was also determined that the Skylab would be in sunlight if the sun elevation angle was greater than -21.6°. Visual sighting opportunities would occur between these limits.

These limits define two segments of the orbit, generally near sunrise and sunset, which continuously satisfy the lighting conditions, so that each time the Skylab passes through those sectors, people on earth who happen to be beneath will have a viewing opportunity. Due to the changing geometry between orbit and sun, the sectors shift slowly around the orbit and change in size with a sixty day period.

The dates and times of the Skylab orbits that met the viewing conditions for each side were determined by a computer program. This program interrogated a data file containing the ascending nodal crossing, sun beta angle, and orbital position of various sun elevation angles for each orbit.

Results

The results for Seattle, New York, and Los Angeles are shown in Figures 1, 2, and 3. Each figure contains two 1973 calendars with the dates of all visible passes marked on one and the dates of visible evening passes marked on the other. The evening passes are shown separately because they

represent the time when the majority of the populace could view the Skylab. These figures are only intended to show a relative frequency of possible observations and not exact dates since dispersions or changes in launch parameters could change the Skylab orbits. Nevertheless, the dispersions might change the specific days of viewing opportunities, but not the occurrence of clustered opportunities that are evident in the evening views which recur in June, August, October, and December. Figure 1 for Seattle shows that viewing is possible on 94 of the 240 mission days, and only 51 of these days had evening passes. Figure 2 shows that New York City will have only 58 days to view Skylab and only 30 days of evening viewing opportunities. Finally, Figure 3 shows that Los Angeles will have only 35 days of viewing and only 19 of these with evening passes. The large difference in number of viewing opportunities is caused by the latitude of the city. Cities close to the maximum 50° latitude have the most opportunities. It should be noted that the S-II stage will be in a similar orbit which laps the Skylab every eleven days. This stage will generally be visible on the same days as that of the Skylab although at different times.

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1025-RCP-1i

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Attachments

References

1. D. J. Belz, Visibility of Orbital Assembly from CSM During Rendezvous, Memorandum for File B71 06046, June 28, 1971.

2. A. W. Zachar, Skylab Saturn Workshop Diffusely Reflected Solar Light at the CSM During Rendezvous, Memorandum for File B71 08007, August 5, 1971.

3. D. J. Belz, Optical Beacons for Acquisition and Tracking of S-191 Targets During Night-Side Passes, Technical Memorandum TM-71-1025-2, April 22, 1971.

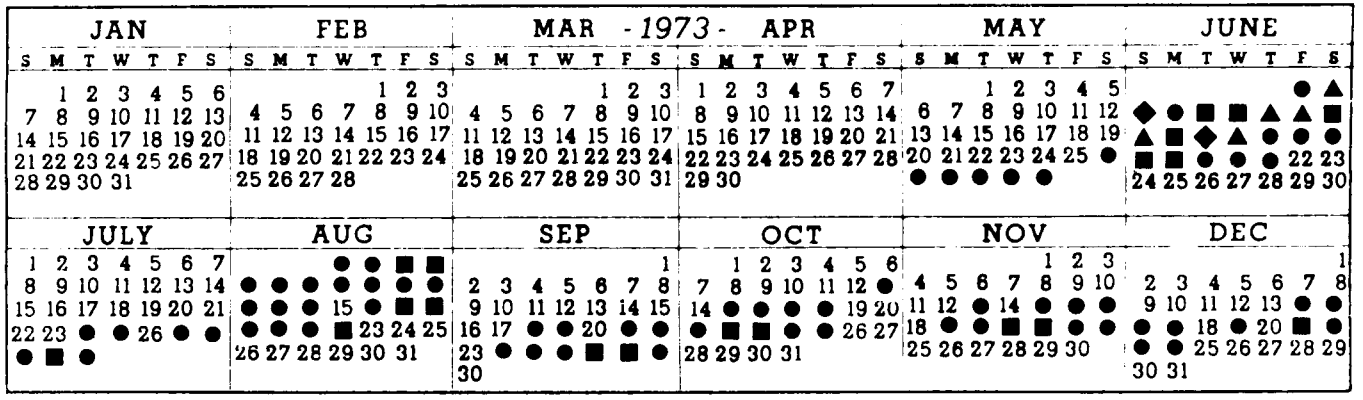
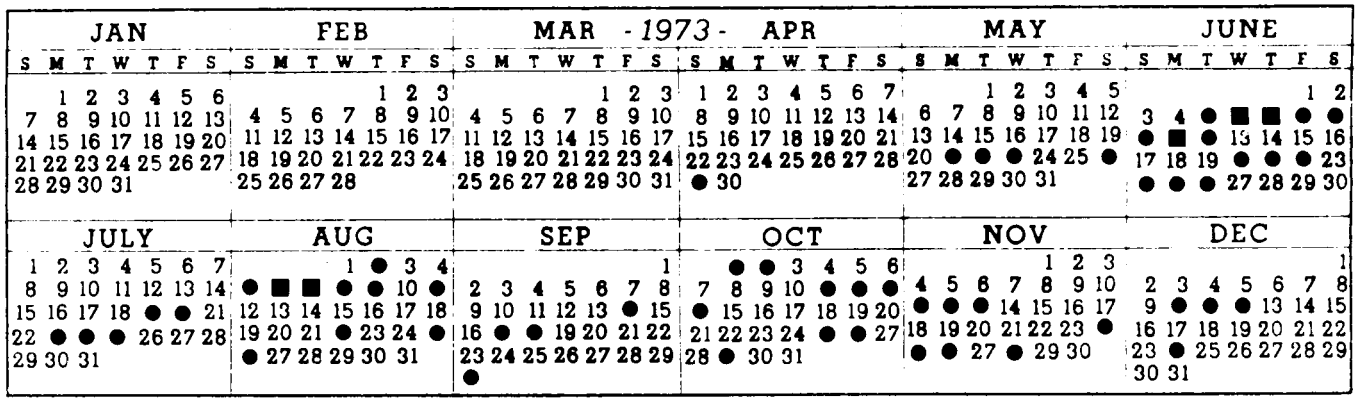


FIGURE 1 - THE VIEWING OPPORTUNITIES FOR SKYLAB FROM SEATTLE



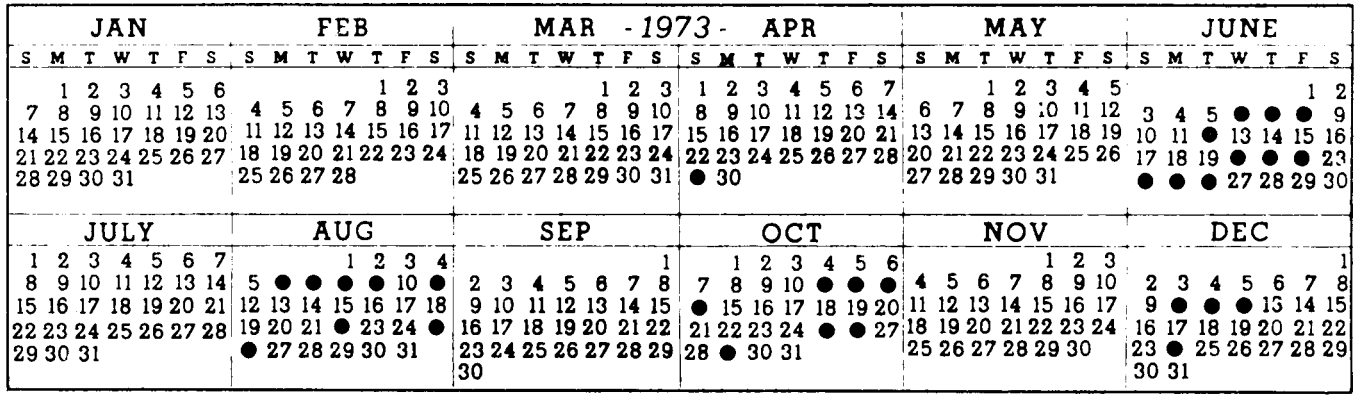


FIGURE 2 - THE VIEWING OPPORTUNITIES FOR SKYLAB FROM NEW YORK

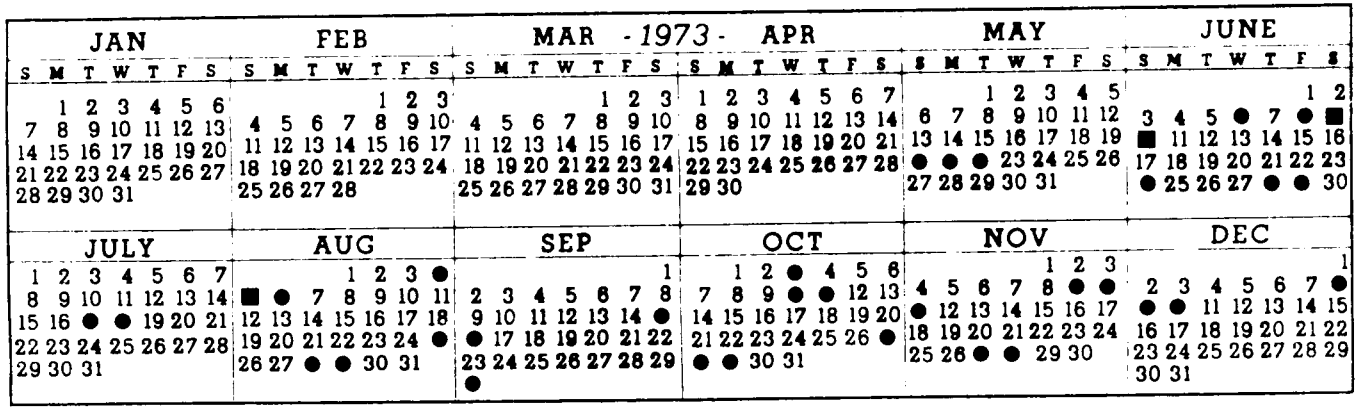


FIGURE 3 - THE VIEWING OPPORTUNITIES FOR SKYLAB FROM LOS ANGELES